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Indian Standard

TEST CODE FOR POWER-OPERATED HYDRAULIC SPRAYER

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Indian Standard

TEST CODE FOR POWER-OPERATED HYDRAULIC SPRAYER

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Indian Standard
TEST CODE FOR POWER-OPERATED HYDRAULIC SPRAYER

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 29 July 1977, after the draft finalized by the Crop Protection Equipment Sectional Committee had been approved by the Agricultural and Food Products Division Council.

0.2 In order to save the crop from pests, the application of pesticides has increased considerably. Power-operated sprayers are increasingly used for this purpose and are being manufactured in large numbers in the country. The power-operated sprayers are based on either hydraulic or pneumatic energy for atomizing and spraying of liquid. An Indian Standard IS : 7593 (Part I)-1975* has already been published to cover the requirements of knapsack type pneumatic sprayer. In case of hydraulic sprayers, it was felt that at first instance a test code should be prepared and at later stage, a specification should be evolved on the basis of data obtained. This test code is being issued to help in evaluating objectively the performance and durability of such sprayers.

0.3 While finalizing this standard, importance of including method of test for droplet size of the spray was felt by the Committee. However, this could not be included at the moment for want of sufficient information. It was, therefore, decided that as and when the details are available, this test will be incorporated.

0.4 In the preparation of this standard, assistance has been taken from the following:

ISO/TC 23/SC 6 N 11 Agricultural sprayers — Method of performance testing. International Organization for Standardization.

Equipment for vector control. World Health Organization.

0.5 In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960†.

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*Specification for power-operated pneumatic sprayer-*cum*-duster : Part I Knapsack type.
†Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard prescribes methods for testing of performance and durability of power-operated hydraulic sprayer.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Hydraulic Sprayer — A sprayer in which the pressure is built up by the direct action of the pump on the liquid spray material.

2.2 Power-Operated Sprayer — A sprayer operated by an electric motor, engine or tractor.

2.3 Spray Pattern — The area and shape of spray deposit produced by a spray nozzle at a given distance from the nozzle orifice.

2.4 Spray Angle — The angle subtended at the final orifice by the edges of the spray pattern.

2.5 Rectangular Distribution Curve — The rectangular form with an even spray deposit across the width.

2.6 Triangular Distribution Curve — A triangular form raising regularly to peak in the centre.

2.7 Row Angle — The angle between the nozzle pointing forward and the nozzle pointing backward when fitted on a boom.

3. SELECTION AND RUNNING IN

3.1 Selection — The sprayer shall be selected at random (*see* IS : 4905-1968*) by the testing authority from the production series. The sprayer shall be complete with its usual accessories and in a condition generally offered for sale.

3.1.1 The manufacturer shall supply the details of the specification of the sprayer consisting of the items given in Appendix A as well as any further data required to carry out the tests. The manufacturer shall also supply all literature, such as operational, maintenance and service manuals, parts catalogues, and tools normally supplied along with the sprayer.

3.2 Running In — The sprayer shall be run in by the manufacturer before the start of actual test under his responsibility in collaboration with the testing authority and in accordance with his usual instructions. The manufacturer may make adjustments during the period of running in. The period of running in and any adjustments made during this period shall be reported.

---

*Methods for random sampling.

4. TESTS

4.1 General Tests

- a) Checking of specifications (*see* **5.1**), and
- b) Checking of material (*see* **5.2**).

4.2 Short-Run Tests

- a) Spraying performance (*see* **6.1**):
  - 1) Discharge rate (*see* **6.1.1**);
  - 2) Spray distribution (*see* **6.1.2**);
    - i) Spray pattern,
    - ii) Working width (swath) of nozzle and boom, and
    - iii) Spray angle and row angle;
- b) Pump efficiency (*see* **6.2**);
- c) Agitation performance (*see* **6.3**);
- d) Pressure adjustment (*see* **6.4**):
  - 1) Pressure fluctuation; and
  - 2) Pressure drop;
- e) Mechanical vibration (*see* **6.5**); and
- f) Visual observations (*see* **6.6**).

4.3 Long-Run Tests

- a) Wear of nozzles (*see* **7.1**), and
- b) Visual observations (*see* **7.2**).

5. GENERAL TESTS

5.1 Checking of Specifications — The specifications given by the manufacturer shall be checked and reported on the form given in Appendix A.

5.2 Checking of Material — The material of construction of different component of the sprayer shall be observed and reported on the form given in Appendix B.

6. SHORT-RUN TESTS

6.0 While conducting the short-run tests the ambient conditions shall be recorded. The ambient temperature shall be not more than 35°C.

6.1 Spraying Performance

6.1.1 *Discharge Rate*

6.1.1.1 The discharge rate per minute shall be measured at maximum and minimum working pressures, specified by the manufacturer, by suitably collecting the test liquid from the nozzle. The discharge rate shall be measured in at least four equal steps between the lowest and the highest pressure. In case the pressure values are not specified, the maximum pressure shall be not more than 500 kPa and minimum not less than 50 kPa. During the test period, the pressure shall be kept constant and the deviations, if any, shall be kept within ±2·5 percent. The tank shall be filled full with clean water. The prime mover shall be operated at a speed specified by the manufacturer. The spray shall be directed for a period timed by stop-watch, into a receiving vessel so designed as to collect the whole of the spray from the nozzle. The measuring period should be at least 60 seconds with an accuracy of measurement of 1 second. The collected liquid from each nozzle shall be measured with an accuracy of ± 2·5 percent.

6.1.1.2 At each pressure setting, the test shall be repeated for a minimum of four times.

6.1.1.3 The average value of discharge for each nozzle for each test pressure shall be obtained and recorded as litres per minute. The sum of the discharge of all the nozzles used in a sprayer shall give the discharge rate of the sprayer.

6.1.1.4 If one or more of the nozzles vary by more than ± 5 percent from the average value of the set, this should be stated in the report. If the deviation is more than 10 percent, another test shall be carried out with a new set of tip or disc of nozzle or with a complete new nozzle.

6.1.1.5 The data shall be recorded according to item (3) of Appendix C as well as graphically illustrated in case of multiple nozzles.

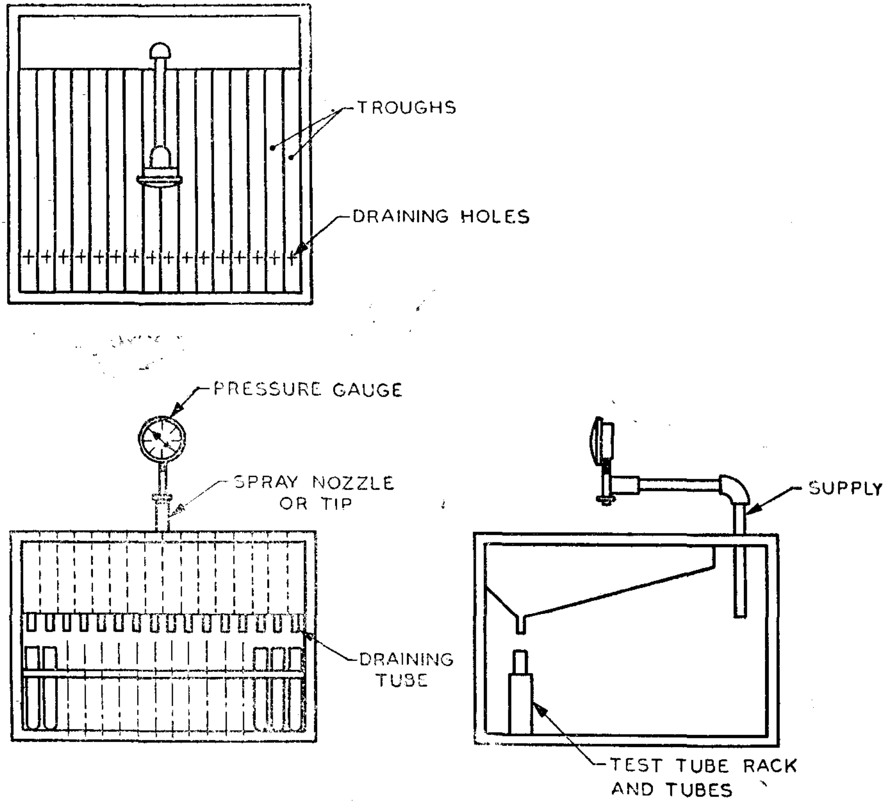
6.1.2 *Spray Distribution*

6.1.2.1 *For nozzle*

a) *Apparatus*

1) *Patternator* — The patternator (*see* Fig. 1) normally consists of 16 channels each 25 ± 0·25 mm wide and of any convenient length provided that it encompasses the area of the spray. The number of channels may be increased or decreased so that the whole of the spray falls within the patternator. The channels lead the liquid directly to the measuring tube having a bore not more than 24 mm and be long enough to hold minimum of 200 ml of test liquid. The depth of the channels shall be

at least 100 mm to avoid rebound of spray droplets. The top edge of the trough dividers shall be sharp (tapered to not more than 0·25 mm width on the top edge) and straight in the horizontal plane, so that no point along with edge lies more than 1 mm from the straight line joining the corresponding points at each end. The top edges of the dividers shall be positioned so that when a straight edge is laid across the full width of the front and back of the troughs no edge lies more than 1 mm below this. Each divider shall be straight in the vertical plane to within ± 0·25 mm.



NOTE — This is a suggested form only. Final details, such as provision of height adjustment are left to the individual.

FIG. 1 PATTERNATOR FOR SPRAY DISTRIBUTION TEST

2) A compressed air supply or small pump giving a steady output, with a liquid supply line from a reservoir of capacity of two litres or more.

3) A constant pressure regulator and a pressure gauge situated as close to the nozzle as possible.

4) Means of holding the nozzle at the correct height with required facilities for adjustments.

5) A test-tube rack so made that the collecting tube can be inserted in the flow when constant flow has been achieved, and retracted after a predetermined period.

b) During the test, the nozzle shall be placed in such a manner that the longest axis is at right angle to the channel edges of the patternator. The axis of the nozzle shall be placed vertically in the middle of the centre channel at correct height. The height above the trough divider shall be 100, 200, 300, 400 and 500 mm.

c) The test place shall be protected from draught and the reservoir shall be filled to any convenient level with clean water. The compressed air supply shall be adjusted to required pressure. The nozzle shall be given a preliminary run until a constant flow rate from the patternator has been achieved. When this condition has reached, the water supply shall be started at specified discharge rate and the receiving tubes shall be inserted under the patternator.

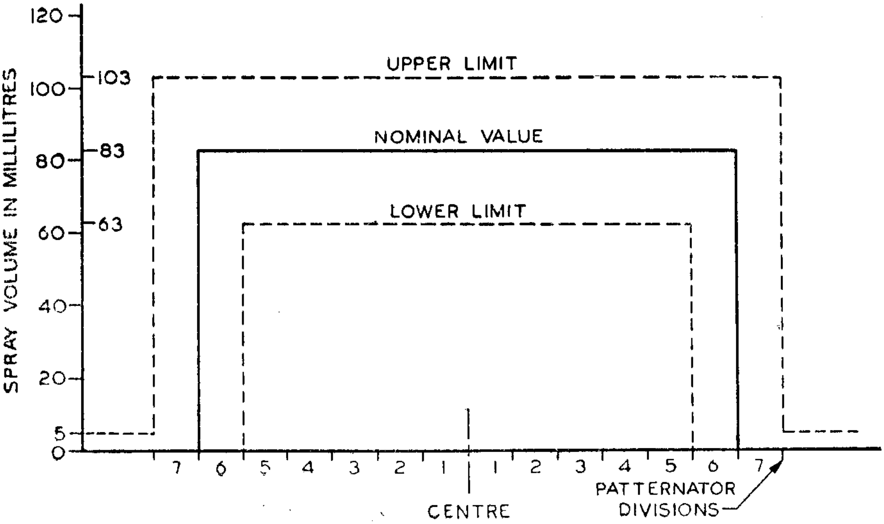
d) As soon as the amount collected in any of the measuring tubes has reached 180 ml, collection is discontinued taking care that no water from the patternator falls into any of the measuring tubes.

e) The volume of the water in each measuring tube shall be determined and a graph prepared by plotting the volume of water in each of the tube against its position in the patternator (*see* Fig. 2 and 3).

f) The test shall be conducted at maximum and minimum working pressures.

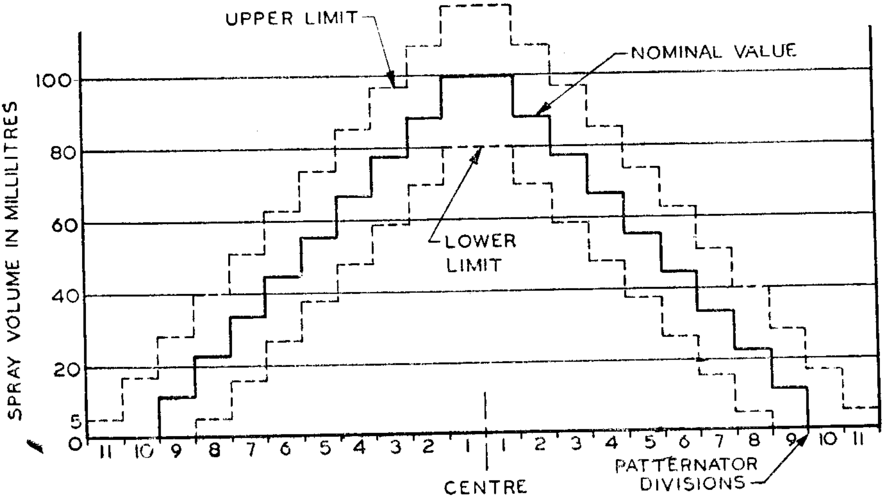
g) The working width (the distance between the outer edges of the outermost channels which at the working pressure received 50 percent or more of the largest quantity of liquid collected from any one channel) in millimetres shall be measured for each of the 100, 200, 300, 400 and 500 mm nozzle height.

h) The spray angle for each nozzle shall be calculated on the basis of working width and nozzle height, and shall be stated in whole degrees.



Based on a total spray volume of one litre.

FIG. 2 RECTANGULAR DISTRIBUTION LIMITS



Based on a total spray volume of one litre.

Tolerance on each division is ±20 ml. Decrement of nominal value outline is 11·1 ml per tube.

FIG. 3 TRIANGULAR DISTRIBUTION LIMIT

6.1.2.2 *For boom*

a) One of the outer section of the booms shall be placed horizontally and at right angle to the channel edges of the patternator [*see* **6.1.2.1**(a)]. If the section has an uneven number of nozzles, the middle nozzle should be placed above the centre channel and in case of even number, the middle point of the distance between two middle nozzles should be placed above the centre channel. The highest and lowest boom height should be as specified by the manufacturer. The largest value should be attained in six stages by increasing preferably 50 or 100 mm the lowest height. If no recommended boom heights are stated, the heights should be 250, 300, 350, 400, 450 and 500 mm above the channel edges.

b) The operations given under **6.1.2.1**(c) and **6.1.2.1**(d) shall be conducted. The test shall be conducted at lowest and highest working pressure and for each of the six boom heights [*see* **6.1.2.2** (a)].

c) The volume of the water in each measuring tube shall be determined and the graph prepared by plotting the volume of water in each of the tube against its position in the patternator. The coefficient of variation is also calculated and illustrated as a function of boom height for each of nozzles and at various testing pressures.

d) The nozzle row angle shall be measured with an accuracy of ± 0·5° and shall be given as the largest angle downwards between the axis of any two nozzles projected on a plane at right angle to the axis of the spray boom.

e) The spacing of the nozzle along the axis of the spray boom shall be measured with an accuracy of ± 1 mm.

6.1.2.3 The data shall be recorded according to item (4) of Appendix C.

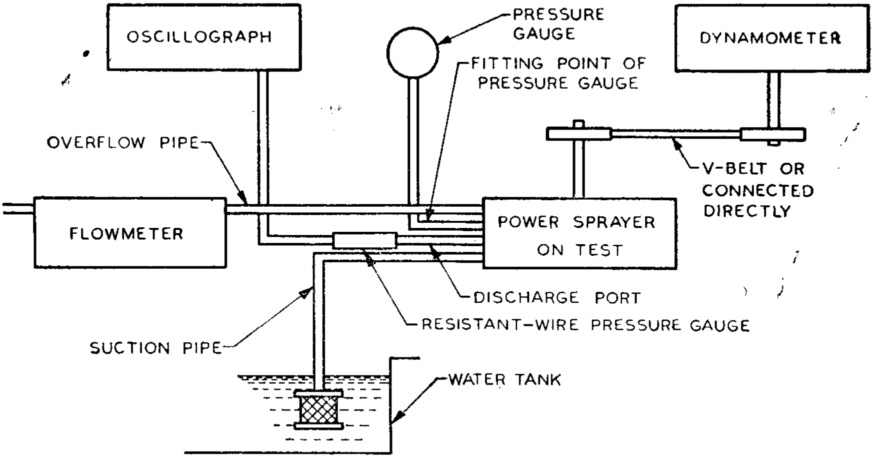
6.2 Pump Efficiency

6.2.1 A dynamometer shall be fitted between the prime mover and the main shaft of the sprayer. The dynamometer shall be so fitted that there is no appreciable angularity at the joints. The angularity if present shall not exceed 7°. In case of electric motor, energy meter should be fitted. A pressure gauge at discharge port shall also be connected (*see* Fig. 4).

6.2.2 The sprayer shall be operated at specified speed and at four pressure stages covering maximum and minimum. The spray shall be collected in receiving vessel for a period of 60 ± 1 seconds. The dynamometer or energy meter reading and pressure gauge reading shall also be taken during the collection of liquid. The amount of liquid collected shall be measured with an accuracy of ± 2·5 percent.

6.2.3 On the basis of above information, power required, hydraulic power and pump efficiency shall be calculated.

6.2.4 The data shall be recorded according to item (5) of Appendix C.



NOTE — This is a suggested form only.

FIG. 4 FLOW DIAGRAM FOR POWER MEASUREMENT

6.3 Agitation Performance

6.3.1 For the test, 2 kg of tracing material consisting of 90 percent wettable sulphur powder having grain size in at least one-third of the powder between 5 and 40 µm and in the rest less than 5 µm, is used. It shall be suspended in about 2·5 litres of water per kilogram of sulphur. The mixture of sulphur and water shall be left for 2 hours and then agitated until it is like a soup. The spray liquid is then added while agitating the mixture.

6.3.2 One litre of test liquid should be tapped and the initial concentration shall be determined by means of evaporation.

6.3.3 *Mixing Time* — After the addition of the tracing material the test liquid shall be left for 2 hours. The test shall be carried out at specified revolutions and at a working pressure of 500 kPa ± 2·5 percent without discharge of liquid through the nozzles passage. Samples of the liquid shall be tapped immediately after the operating device. A total of 10 samples shall be tapped at intervals of 30 seconds. The first collection shall be made after 30 seconds of the start. The concentration of the samples collected shall be given in a table or illustrated graphically as a function of time.

6.3.4 *Effectiveness of Agitation* — The testing shall be started after a period of mixing (*see* **6.3.3**) which ensures that the spraying liquid is as homogeneous as possible.

6.3.4.1 The sprayer shall be operated at its specified revolution and pressure by discharging the total content of the tank with all nozzles open. When 10 percent of the liquid is discharged, a sample shall be tapped from randomly chosen nozzle except from the one at the tip of the boom. At intervals of 10 percent, samples shall be tapped from the same nozzle until the tank is empty. The concentration of the samples collected shall be given in a table or illustrated graphically as a function of time.

6.3.4.2 At the end of the test, the sulphur deposit in tank shall be collected and shall be reported as percentage of quantity originally added.

6.3.5 The observations shall be recorded according to item (6) of Appendix C or illustrated graphically.

6.4 Pressure Adjustment

6.4.1 The sprayer fitted with pressure gauge shall be operated at four stages of pressure covering the minimum and maximum, and at specified speed for minimum of 30 minutes. At every pressure setting, the fluctuation of the pressure shall be recorded. The pressure drop when the sprayer is discharging 90 percent of suction volume under the total overflow operation (the operation by utilizing total volume of discharge in the arrangement of getting it back through overflow pipe) shall be recorded. The ratio between the decreased pressure and normal pressure expressed as percentage shall be reported.

6.4.2 The air pressure chamber shall be tested separately at a pressure 2·5 times the normal working pressure or 1·5 times the maximum working pressure whichever is more for a minimum of 30 seconds, to see the pressure resistance of the chamber.

6.4.3 The observations shall be recorded according to item (7) of Appendix C.

6.5 Mechanical Vibration — The amplitude of vibration of various components of the sprayer shall be measured at rated speed of the prime mover after mounting the sprayer. The maximum amplitude of vibration shall be measured in horizontal and vertical position of the accelerometer and should be represented in micrometre for horizontal displacement (HD) and vertical displacement (VD). The data shall be reported according to item (8) of Appendix C.

6.6 Visual Observations — During and after short-run test, the sprayer shall be visually examined. The observations given in item (9) of Appendix C shall be made and recorded.

7. LONG RUN TEST

7.1 The sprayer shall be operated at specified normal working pressure and speed continuously for a period of minimum 50 hours. The discharge from the nozzle shall be collected for a period of 15 minutes after 15 minutes of running for the first time. After first collection, subsequent collection of the discharge shall be done for the period of 15 minutes after every 8 hours run. The variation in discharge from first collection to last would give the percentage wear of nozzle.

7.2 During the operation, the sprayer shall also be examined visually (*see* **6.6**).

7.3 The observations shall be recorded in Appendix D.

APPENDIX A

(*Clauses* 3.1.1 *and* 5.1)

SPECIFICATION SHEET

	To Be Filled In By	
	Manufacturer	Testing Authority
1. General		
a) Make		
b) Model		
c) Type		
d) Serial number		
e) Manufacturer		
2. Prime Mover		
a) Make		
b) Type		
c) Model		
d) Power rating		
e) Country of origin		
3. Cylinder		
a) Number		
b) Disposition		

TO BE FILLED IN BY

Manufacturer Testing Authority

- c) Bore/stroke
- d) Capacity
- e) Compression ratio
- f) Cylinder lining

4. Fuel and Ignition System

- a) Fuel feed
- b) Carburettor
- c) Ignition
- d) Magneto contact breaker point gap
- e) Size of spark plug
- f) Electrode gap of spark plug
- g) Capacity of fuel tank
- h) Ignition timing

5. Air Cleaner

- a) Type
- b) Location

6. Lubrication

- a) Type
- b) Ratio of petrol & mixing oil
- c) Grade of mixing oil

7. Cooling System

- a) Type
- b) Blower

8. Type of Starting System

9. Tank

- a) Size
- b) Capacity
- c) Method of mounting
- d) Maximum sustained pressure without leakage
- e) Safe pressure for spraying operation

To Be Filled In By

Manufacturer Testing Authority

10. Frame

a) Type
b) Diameter of pipe

11. Blower Assembly

a) Type of impeller
b) Diameter of impeller
c) Number of vanes
d) Details of drive
e) Capacity, m^3/s
f) Air velocity at rated engine speed, m/s

12. Air Deflector

a) Type
b) Length of deflection hose
c) Ease of adjustment

13. Agitating Device

a) Location
b) Type
c) Method of working
d) Method of pressure regulation

14. Nozzle

a) Type
b) Size of nozzle and discharge

Nozzle No.	*Discharge*
1	
2	
3	
4	
5	

	To Be Filled In By	
	Manufacturer	Testing Authority
15. Mounting Arrangement		
16. Accessories (for Operator's Safety Against Pesticides)		
17. Overall Dimensions		
a) Length (with hose)		
b) Length (without hose)		
c) Width		
d) Height		
18. Total Mass		
a) With all accessories and without fuel and chemical		
b) With all accessories and fuel and chemical tank full		

Note 1 — The item which is not applicable in a particular sprayer should be crossed while filling.

Note 2 — If any other items are provided their detail should be filled in.

APPENDIX B

(*Clause* 5.2)

DATA SHEET — MATERIAL OF CONSTRUCTION

SL NO.	NAME OF COMPONENT	MATERIAL
(1)	(2)	(3)
i)	Pump	
ii)	Spray tank	
iii)	Boom	
iv)	Lances	
v)	Nozzle body	
vi)	Nozzle cap	
vii)	Nozzle disc and tip	
viii)	Swirl core	
ix)	Frame	
x)	Others	

Testing Engineer

APPENDIX C

(*Clauses* 6.1.1.5, 6.1.2.3, 6.2.4, 6.3.5, 6.4.3, 6.5 *and* 6.6)

DATA SHEET — SHORT RUN TESTS

1. Date

2. Atmospheric Conditions

- a) Temperature
- b) Relative humidity
- c) Pressure

3. Discharge Rate

Specified Speed, rev/min	*Working Pressure,* kPa	*Test No.*	*Discharge from Each Nozzle,* ml/min					*Average Discharge*	*Total Discharge*
			(1)	(2)	(3)	(4)	(5)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		1							
		2							
		3							
		4							
		5							
		Average							

4. Spray Distribution

- a) Number of channels in patternator
- b) Slope of patternator
- c) Data for nozzle

Working Pressure, kPa	*Height of Nozzle,* mm	*Quantity of Liquid from Nozzle at Channels,* ml				*Percentage of Largest Quantity of Liquid Collected*	*Working Width,* mm	*Spray Angle,* degrees
		1	2	3	etc			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	100							
	200							
	300							
	400							
	500							

d) Test Data for Boom

Working Pressure, kPa	*Boom Height,* mm	*Quantity of Liquid Collected from Each Nozzle at Channels,* ml				*Coefficient of Variation of Distribution of Each Nozzle*	*Working Width,* mm	*Spray Angle,* degrees
		1	2	3	etc			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	250							
	300							
	350							
	400							
	450							
	500							

5. Data Pump Efficiency

Test No.	*Pressure Gauge Reading*	*Energy Meter or Dynamometer Reading*	*Speed,* rev/min	*Required Power,* kW	*Discharge,* l/min	*Hydraulic Power,* kW	*Pump Efficiency,* percent
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1)							
2)							
3)							
4)							

6. Data for Agitation

a) Initial concentration

b) Mixing time and effectiveness

Sample No.	*Concentration*
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

c) Quantity of tracing material remains in tank after operation

7. Data for Pressure Adjustment

a) Observations

Working Pressure	*Fluctuation Range*	*Pressure Drop*	*Ratio*

b) Resistant of pressure — yes or no.

8. Mechanical Vibration

a) Make of the meter
b) Type
c) Type of Accelerometer
d) Observations

Sl No.	*Location of the Accelerometer*	*Horizontal Displacement*, µm	*Vertical Displacement*, µm
(1)	(2)	(3)	(4)
1)	Cylinder head		
2)	Spark plug		
3)	Flange of the carburettor		
4)	Air intake (carburettor)		
5)	Choke lever		
6)	Accelerator cable end		
7)	Carburettor tickler		
8)	Engine bell housing		
9)	Magneto housing bolts		
10)	Exhaust flange		
11)	Engine foundation		
12)	Base frame		
13)	Blower housing nuts		
14)	Bolts fixing the air outlet pipe		

Sl No.	*Location of the Accelerometer*	*Horizontal Displacement*, μm	*Vertical Displacement*, μm
(1)	(2)	(3)	(4)
15)	Fuel cock		
16)	Tank mounting bracket		
17)	Back rest		
	i) Front		
	ii) Rear		
18)	Accelerator knob		
19)	Delivery hose clamps		
	i) Front		
	ii) Rear		

9. Visual Observations

a) Easiness of transporting

b) Easiness of operating

c) Proper tightness of fasteners

d) Any marked vibration

e) Any undue knocking or rattling sound

f) Any leakage of liquid or oil

g) Any deformation or breakdown

h) Marked wear of any component

j) Any other observations

Testing Engineer

APPENDIX D

(*Clause* 7.3)

DATA SHEET — LONG RUN TEST

1. Total Running Time

2. Quantity of The Liquid Collected

- a) First collection
- b) Second collection
- c) Third collection
- d) Fourth collection
- e) Fifth collection
- f) Sixth collection
- g) Last collection

3. Percentage Variation of Discharge from First to Last Collection

4. Visual Observations (*see* **9** of Appendix C).

Testing Engineer

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Conversion*
Force	newton	N	1 N = 0·101 972 kgf
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2